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Water Cycle Management Stormwater Concept

Bayside Brunswick

Proposed Subdivision of Lot 1 DP871093
Brunswick Heads
for Codlea Pty Ltd

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1. Introduction

Landpartners Limited has been engaged by Codlea Pty Ltd to prepare a Stormwater Management Plan for inclusion in the request to the Department of Planning (DoP) to subdivide the land for future residential development. This report has been compiled to detail the provision of on-site stormwater controls for the development in accordance with the principles of Water Sensitive Urban Design (WSUD) in order to provide drainage for the proposed development and to maintain and/or enhance the habitat for the local flora and fauna.

This stormwater concept has been developed under the Director General's requirements (issued 14.10.10, items 4.2 – 4.4) which requests that measures for Integrated Water Cycle Management (including stormwater) based on WSUD are addressed and outlined. For the preparation of the concept the *Byron Shire Councils Development Control Plan DCP 2002, Part N, Stormwater Management* as well as the relevant design guidelines and stormwater models used in contemporary stormwater design have been considered. Preliminary analysis confirms that the requisite performance targets for stormwater runoff and water quality are achievable.

2. Subject Site and Existing Drainage Regime

The subject site for the report is Lot 1 DP871039 Bayside Way, Brunswick Heads; its location is shown on **Figure 1**. The site is a greenfield development of approximately 31ha, in an area zoned 2(a) Residential, with a large area of land in the east of the Site zoned for Environmental Protection as either 7(a) Environmental Protection (Wetlands) or 7(b) Coastal Habitat in the Byron Local Environmental Plan (1988), as shown on **Figure 2**.

The site consists predominately of slashed heathland and grassland with areas of native vegetation and is generally flat or very gently sloping in the area proposed for development. It is bound to the north by urban development, to the east by Simpsons Creek to the west by rural land and to the south by vacant land.
The soil profile has been investigated at a number of locations by Border-Tech Geotechnical Engineering Services (see report BT 19034-1 of May 2009). Sand was found in all bores which ranged between 2m to 6.3 m in depth. It is anticipated that these soils will have good permeability and will absorb rainfall readily. Therefore an infiltration rate reflecting the sandy subsoil was used in stormwater modelling.
Groundwater at shallow depth typically between 0.3 and 0.8m in the lower lying areas was observed during the Border-Tech investigation.

The majority of the site, defined by two low, flat ridges running north south on the eastern and western side, is currently draining to the south along an existing open drain which ultimately flows into Simpson Creek via Everitts Creek. The area east of the low eastern ridge drains towards the coastal zone and the existing canal adjacent to the north. The area west of the western ridge generally drains south and west into the adjacent lower lying areas. Existing drainage lines are generally overgrown and silted up.

During a community meeting on site, reports of locally poor or slow drainage were made by some residents from the adjacent estate. The proposed SW concept identifies areas of poor drainage and will provide improvements to the drainage regime by re-instating and maintaining clear drainage paths. All common lines (IAD) will be protected by easements and a drainage reserve will be created for the bio-retention basin which will receive the majority of the piped flows.
It is assumed that the existing drainage path downstream of the basin outlet will be accessible for maintenance and will continue to act in its current function as outfall for the main drainage from the site. Maintaining a clear outfall path is essential for the stormwater management measures to operate in a manner intended by the design.

Figure 1. Locality plan

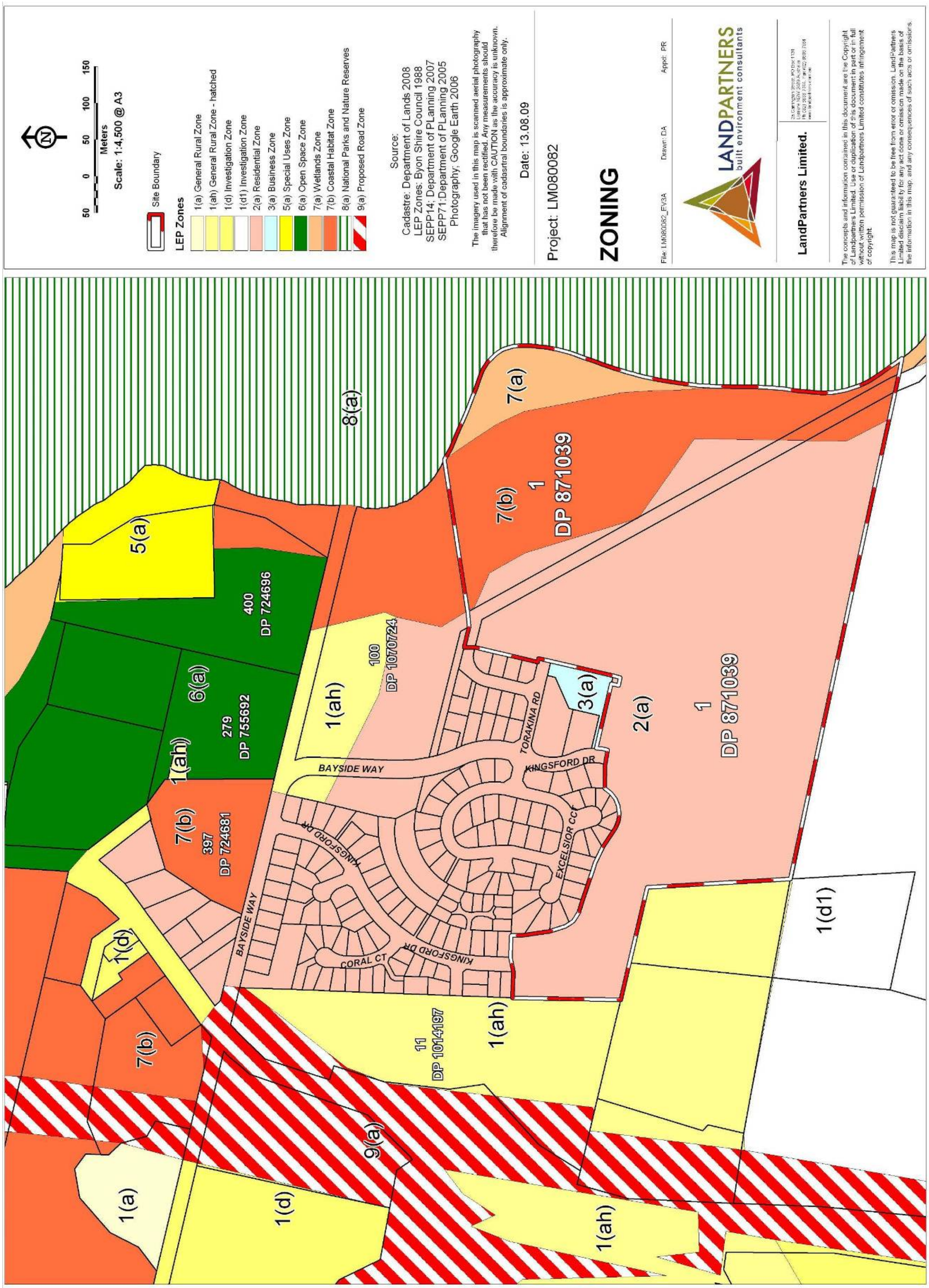


Figure 2. The subject site and zoning

2. Proposed Development & Drainage Concept

It is proposed to develop the land by subdividing it into predominantly single dwelling allotments and a medium density lot adjacent to the business area (3(a) Zone), serviced by subdivisional infrastructure including a network of roads, reticulated utilities and stormwater drainage. Details of the concept layout indicating the proposed drainage network are shown in **Figure 3**.

It is intended to maintain existing drainage path and catchment boundaries for surface flows and as far as practical for piped flows. The addition of treatment areas and detention in the main drainage reserve (Park 2) as well as additional treatment beds in sensitive areas will ensure that stormwater quality targets will be met and controlled discharge of stormwater runoff will be achieved.

Existing and proposed elevations at the site range between 2.2 and 5.8m AHD with levels for the residential lots and the building areas above 4m AHD. Figure 7-8 of BMT-WBM's Report 'Final Flooding and Coastal Advice for the Bayside Brunswick Development' shows the areas proposed for development of the subject site to be outside the reach of the 1 In 100 years ARI flood. BMT-WBM modelling predicts 1% flood levels in Everitts Creek at the junction with the outfall drain from the site to be 3.2 AHD.

Based on these findings it is contended that the effects of flooding from downstream creeks and waterways will be limited on the proposed development. Modelling carried out during conceptual design for the proposed drainage system indicates that local flooding caused by rainfall events on the site and the existing small upstream catchment discharging at the pipe outlet in Kingsford Drive will be contained within the proposed drainage reserve. The main catchment outlet is controlled by a culvert under the road on the southern edge of the site and its overflow weir at an elevation of 3.5m AHD.

Figure 3. Drainage Concept

The proposed drainage scheme endeavours to enhance drainage by improving definition of the drainage lines within the development and by restoring function and capacity of the existing outfall drains whilst generally maintaining the existing regime and flow paths. Minimal earthworks are proposed and will be generally related to the construction of the road network with some allotment reshaping to provide self-draining surfaces. Great care was taken in the development of the layout to preserve trees and limit disturbance to vegetated areas outside the road network. Significant habitat areas will be maintained as illustrated in Figure 4.

For the smaller catchments on the northern and eastern side of the site it is proposed to use existing drains and flowpaths as outfalls for the formal drainage. At each pipe outlet filtration beds to control water quality will be installed.

Proposed lots B160 & B167 have been left as large single dwelling lots to preserve the existing drainage pattern as well as retain trees. A filter bed on Lot B167 will be installed downstream of the piped outlet to act as spreader of flows and to increase water quality. Lots B161 to B166 will maintain the existing grade towards the south and will have individual filter trenches along the boundary to spread and treat flows without changing existing runoff patterns.

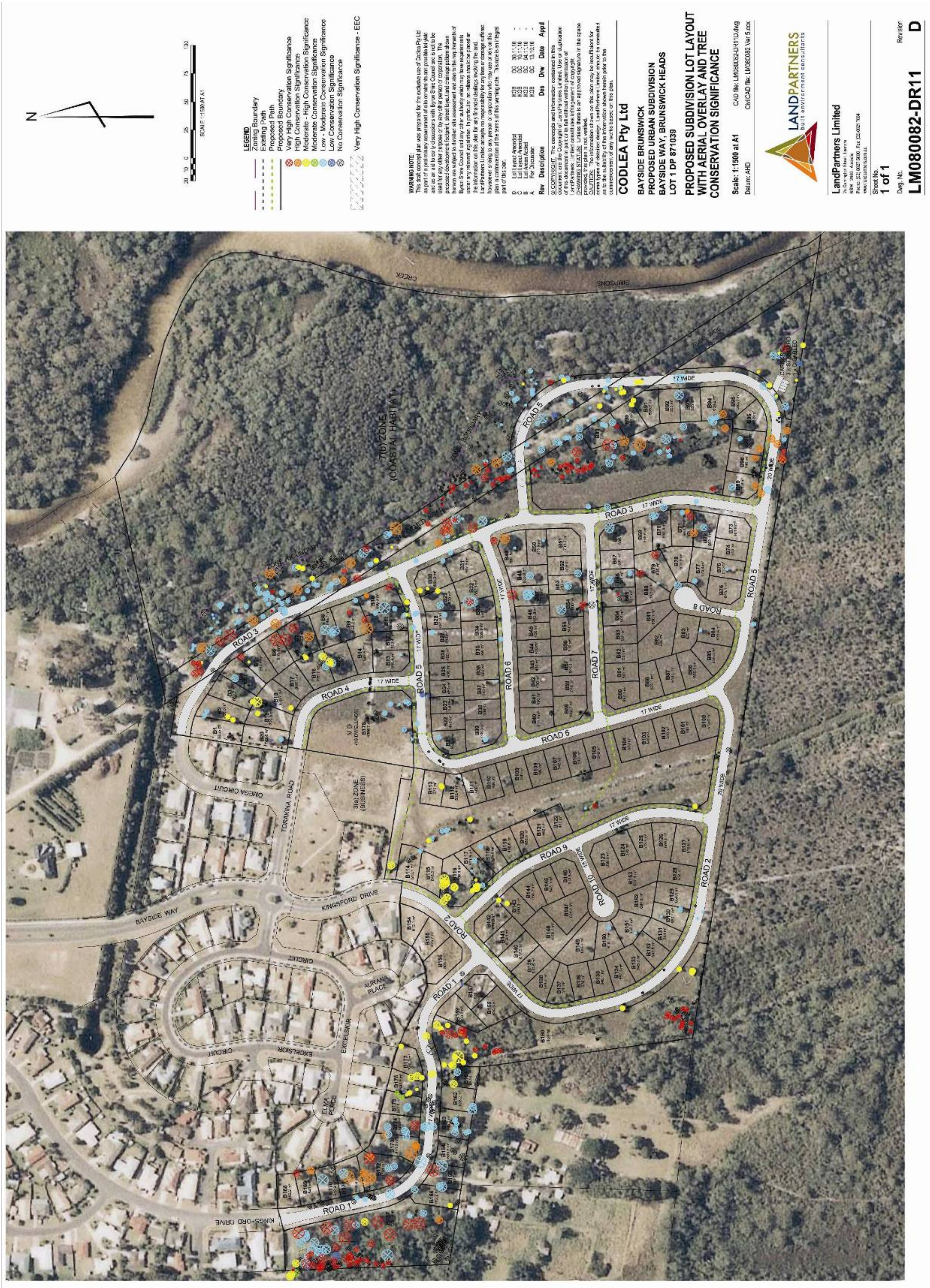


Figure 4. Subdivision Layout with Aerial Overlay and Existing Trees

3. Stormwater Treatment and Quality

Water Sensitive Urban Design (WSUD) requires the adoption of systems which preserve the water cycle by reducing demand for reticulated water, re-using waste-water, and returning water to the water table. These measures are intended to reduce pollutant transportation from the developed site and maintain the quality of runoff in a pre-development condition.

3.1 Overview

Increases in pollutant and hydraulic loads from residential development arise primarily from,

- An increase in impervious areas associated with roads, driveways and buildings, and
- The deposition and subsequent washing off of pollutants on road and driveways.

Hard surfaces accumulate a range of pollutants during dry periods which may be released to receiving waters during rainfall events. As a result, there is potential for stormwater flow rates and pollutant volumes to be higher after development than beforehand. This may result in adverse impacts upon downstream water-bodies and ecosystems, unless appropriate mitigation measures are taken.

- The management techniques utilised on this site revolve predominantly around runoff control by encouraging infiltration, filtration trenches and spreaders at pipe outlets, a large bio-retention basin with treatment / filtration bed for the stormwater arriving via the piped road and IAD system as well as surface flows.
- Gross pollutants from the roads will be captured prior to entering the treatment systems with suitable gross pollutant traps (GPTs) located either at the end of line or at kerb inlet pits.

4. MUSIC Modelling

The current and proposed site conditions have been modelled in Model for Urban Stormwater Improvement Conceptualisation (MUSIC) V3.0 to quantify the existing and expected contaminant loads exported as a result of the proposed residential development of previously undeveloped rural land. The identification of baseline stormwater outputs for the undeveloped site was followed by modelling the proposed development scenario.

This final MUSIC model was run in order to demonstrate the recommended treatment trains ability to satisfy the relevant stormwater quality targets, as recommended in BSC – DCP 2002, Section N7 will be achieved or exceeded.

4.1 References

The MUSIC modelling undertaken was based on the following references as well as the site assumptions listed below:

- Soil information gathered from various sources and onsite assessment.
- Source node data provided by the Tweed Shire Council.
- Pollutant treatment and loading parameters provided from Tweed Shire Council MUSIC modelling guidelines.

4.2 Model Parameters and Assumptions

4.2.1 Catchment Areas

Modelling has been conducted for the proposed development area (refer **Figure 3**) totalling 19.74ha. Areas outside the footprint were not included in the MUSIC stormwater quality model. The development footprint is divided into 5 main catchments as listed below.

North = 1.04ha with 9 lots
West = 1.14ha with 3 lots
South = 0.6ha with 8 lots
Central = 14.16ha with 137 lots
East = 2.8ha with 20 lots.

The eastern catchment is broken into 3 sub catchments based on the treatment measures.

4.2.2 Weather Data

The model uses 6-minute time step data from Murwillumbah rainfall data set (1996 – 2006) as it is the data which best represents Mullumbimby's rainfall patterns. MUSIC modelling as MUSIC requires a minimum 10 year long record of measured rainfall data to allow for a warm-up period and a representative variety of storm events.

Monthly Average Potential Evapo-Transpiration figures were sourced from the Bureau of Meteorology data for the Tweed area. The figures used (mm/month) are Jan 165, Feb 135, Mar 135, Apr 99, May 70, Jun 60, Jul 60, Aug 75, Sep 105, Oct 135, Nov 150 Dec 16.

4.2.3 Node Parameters

The catchment node parameters used in the MUSIC modelling were taken from the Tweed Shire Council MUSIC modelling guidelines. The pre-development 19.74ha catchment is modelled using the "Tweed Rural" node. While the proposed 19.74ha development is modelled using the "Urban Residential Tweed" node.

4.2.4 Pollutants Modelled

MUSIC allows for modelling of the following water quality parameters:

- Flow
- Total Suspended Sediment (TSS)
- Total Phosphorus (TP)
- Total Nitrogen (TN)
- Gross Pollutants

4.3 Pre-Development Conditions

To establish the pre-development site conditions, the MUSIC model was run with the following input variables:

- Predevelopment Agricultural – 19.74 ha
- Source(s)
    - Rural (Tweed) – 19.74 ha: 100% Pervious
- Receiving
    - Open drain leading to Simpsons Creek

4.4 Post-Development

To evaluate the change in stormwater flows and water quality as a result of the proposed development compared to the existing development, the MUSIC model was run with the following input variables (Refer Figure 5):

- North Catchment
  Urban Residential – 0.86 ha: 70% Pervious 30% Impervious
  Roof Area – 0.18ha 100% Impervious

- East Catchment (in 3 sections)
  Urban Residential – 2.4 ha: 70% Pervious 30% Impervious (typical)
  Roof Area – 0.4ha 100% Impervious

- Central Catchment
  Urban Residential – 1 ha: 75% Pervious 25% Impervious
  Roof Area – 2.74ha 100% Impervious

- South Catchment
  Urban Residential – 0.44 ha: 70% Pervious 30% Impervious
  Roof Area – 0.16ha 100% Impervious

- West Catchment
  Urban Residential – 0.54 ha: 50% Pervious 50% Impervious (treated)
  Urban Res – 0.54 ha: 90% Pervious 10% Impervious (not treated)
  Roof Area – 0.06ha 100% Impervious

The output data for this run is presented in Section 5 Music Modelling Results.

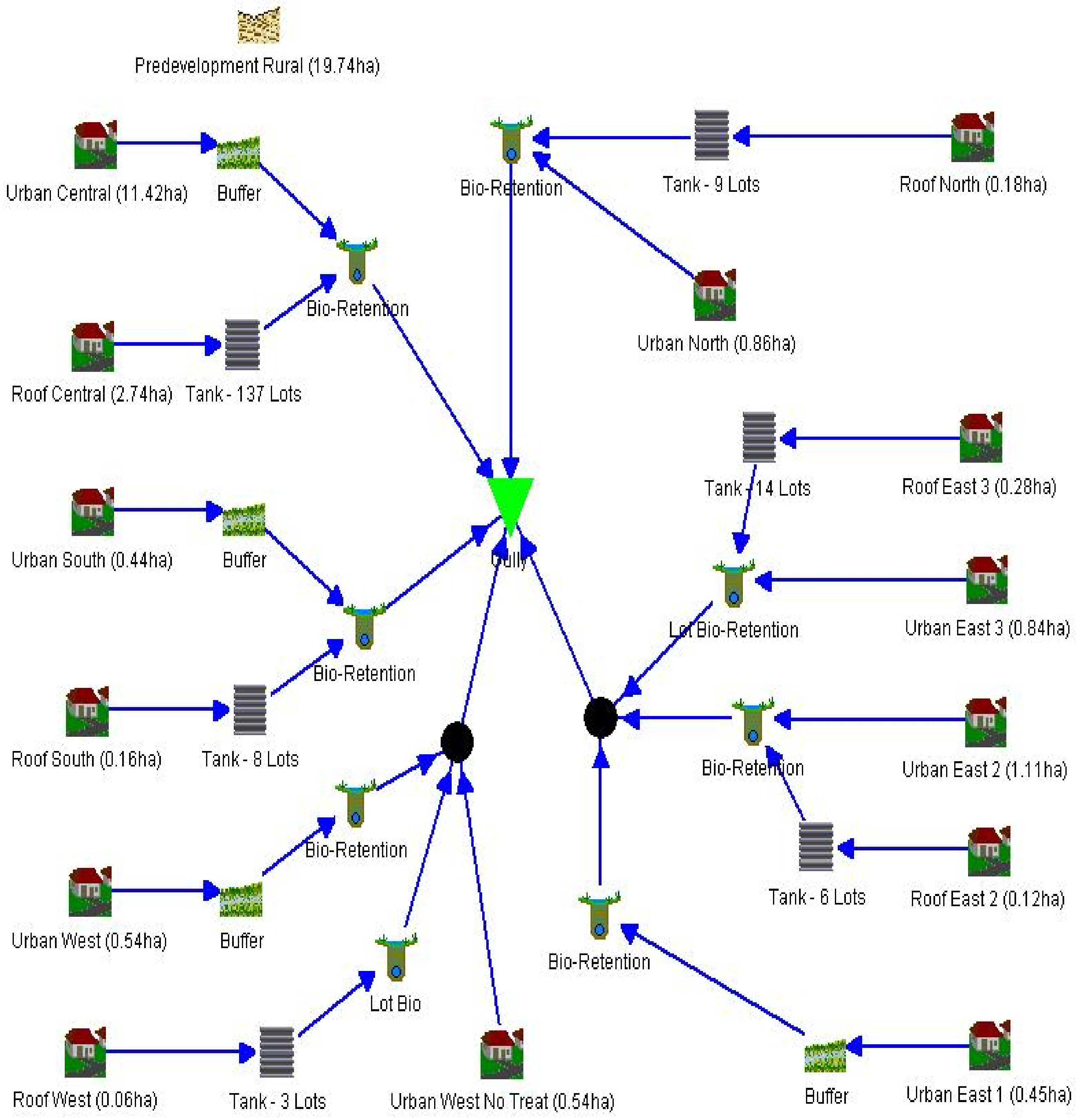


Figure 5: MUSIC modelling schematic for current development

4.5 Stormwater Quality Improvement Device Parameters

The parameters selected for the stormwater quality improvement devices are:

4.5.1 Gross Pollutant Traps (GPT's)

The gross pollutant traps will remove the majority of large pollutants prior to the water arriving at the bio retention swales for final treatment and removal of particulate matter. The GPT's will minimise the amount of maintenance required for the bio retention swales and improve the overall quality of the stormwater leaving the proposed development.

The model assumes that gross pollutant will be removed by suitable capture systems (GPTs), at outlet headwalls prior to entering the treatment / filtration beds (end of line) or at the kerb inlet pits (in line). Typical systems currently used in various local government areas and suitable for this application are:

- Ecosol Net-Tech filters bags attached to each headwall outlet.
- Ecosol or SQID pit inserts at kerb inlet pits.

Typical performance of one of such filters is illustrated in **Table 4.1** below:

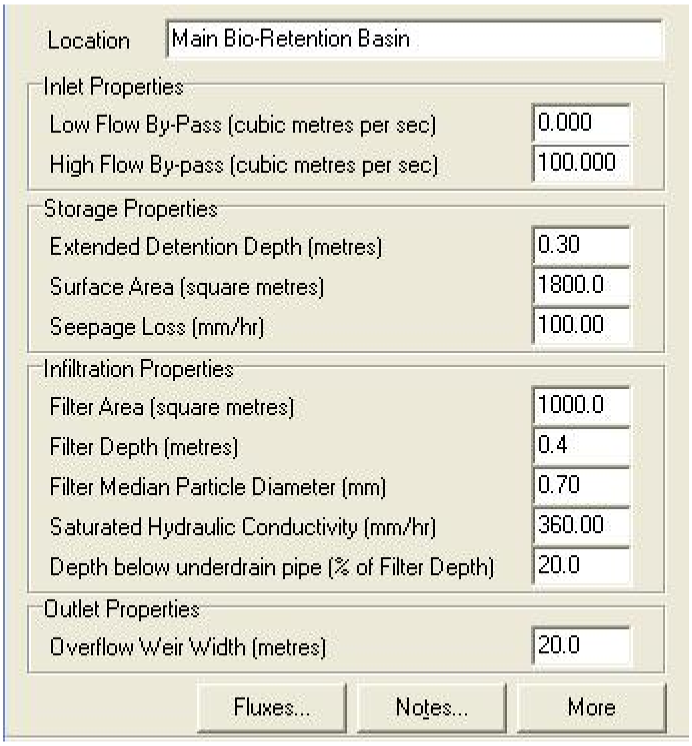
Sieve Size (mm)	Capture Efficiency
> 19.00	91%
> 13.00	67%
> 6.70	47%
> 2.36	20%
> 1.78	17%
> 0.15	11%

Table 4.1: Ecosol Net Tech pollutant removal efficiency

4.5.2 Bio-retention Basin

The fundamental principle behind the function of bioretention Systems for stormwater quality improvement is the use of soil and plants to delay, attenuate and facilitate the removal of pollutants from localised catchment runoff. They promote the removal of particulate and soluble contaminants by passing stormwater through a filter medium, thus reducing concentrations of TSS, TP and TN. The bio retention will also reduce the peak stormwater flows by providing a detention volume prior to the water being treated by the filter media or released via the low flow pipes.

Bio Retention treatment node inputs:



The stormwater basin consists of:

- o 1:6 sloping grassed banks of 3-5%
- o grassed base with crossfall of 1% and longitudinal fall of 0.1% leading to bio-retention filter media. Subsoil drain located in invert.
- o 1000m^2 of 400mm thick sandy loam filter media. (0.7mm dia, 360mm/hr permeability_
- o 2 x 225 dia slotted Ag. Low flow pipe to drain existing gully and filter media
- o 5 x 450 dia round concrete mid flow pipes or equivalent RCBC option
- o 20m long high flow concrete spillway over road with batter protected with rock mattresses.

A total of 3500^3 of detention storage is provided up to the spillway level of 3.5. This storage is sufficient for events up to 10 year intensities. Events greater than 10 years will discharge over the spillway. The existing downstream gully is to be reshaped with a 1m wide base and 1:1.5 typical batters and 2.5m deep.

4.5.3 Bio-retention Swales

The bio retention swales are designed to promote the removal of particulate and soluble contaminants by passing stormwater through a filter medium, thus reducing concentrations of TSS, TP and TN. Each swale is a different length and width but typically consists of a 400-600mm deep filter sand bed for the length of the swale. The sides of the swales are generally 1:4 grassed batters which can be easily cleaned and maintained. The detention depth of each swale is 300mm which negates the need for any public safety fences to be installed. Each swale will have a level edge to allow shallow, low velocity over each edge. Final design of the bio-retention swales will be done as part to the construction certificate application.

Typical Bio-Retention Swales (Road Treatment)

• Extended Detention Depth (m)	0.3 typical
• Surface Area (m^2)	60-120m^2

Infiltration Properties

• Area (m^2)	40-90m^2
• Filter Depth (m)	0.4-0.6
• Filter Median Particle Diameter (mm)	0.7
• Saturated Hydraulic Conductivity (mm/hr)	360
• Length (m)	15-30m
• Width (m)	2-3m

Typical Bio-Retention Swales (Roof Treatment)

• Extended Detention Depth (m)	0.3 typical
• Surface Area (m^2)	30m^2

Infiltration Properties

• Area (m^2)	15m^2
• Filter Depth (m)	0.4
• Filter Median Particle Diameter (mm)	0.7
• Saturated Hydraulic Conductivity (mm/hr)	360
• Length (m)	15m
• Width (m)	1m

For individual lots adjacent to sensitive areas (eastern catchment) and where surface only discharge is possible (southern catchment) bio-filtration strips of 15x1m typical size were included in the model.

4.5.4 Roofwater Tanks

Rainwater tanks are to be installed on each lot. Tanks are required by BASIX for new dwellings. The modelling was done assuming a 5000 L tank will be in operation at each lot. The main effect on SW quality of the tanks is to reduce nitrogen levels in the roofwater runoff.

For the purpose of simplifying the input the complexity of the model, a virtual single tank has been created for each catchment representing the number of lots in the respective sub-catchment. The virtual tank reflects the combined outflow of the individual tanks in the model with the storage, static head and outlet configuration set to mimic the actual conditions. It was assumed for modelling that the daily drawdown per household for non potable re-use water is 200 L.

5. MUSIC Modelling Results

5.1 Pollutant Levels

Results of the pollutant levels modelled for the proposed development are based on Tweed Shire Councils MUSIC node parameters.

Pollutant	Existing Site (kg/yr)	Developed Site without treatment (kg/yr)	Developed Site with treatment (kg/yr)	Development Load Reduction (%)*
Total Suspended Solids	3950	15300	2360	84.6%
Total Phosphorus	9.91	37.7	10.4	72.4%
Total Nitrogen	57.0	230	105	54.2%
Gross Pollutants	0.00	3180	34.0	91% #

Table 5.1: Pollutant Levels

** Load reduction compares "Developed Site without treatment" to "Developed Site with treatment".*
 # Gross pollutant reduction is based on independent testing of Ecosols Net Tech for gross pollutants greater than 19mm.

5.2 Proposed Development Pollutant Load Increase

The increase of the pollutant load due to the proposed development is:

Pollutant	Existing Site (kg/yr)	Developed Site with treatment (kg/yr)	Overall Pollutant Change (%)*
Total Suspended Solids	3950	2360	-40.2%
Total Phosphorus	9.91	10.4	+4.9%
Total Nitrogen	57.0	105	+84%
Gross Pollutants	0.00	34.0	-

Table 5.2: Pollutant Load Increase
** Pollutant Change compares "Existing Site" to "Developed Site with treatment".*

5.3 Water Quality Target Comparison

Byron Shire Councils stormwater quality targets are outlined in BSC's Stormwater Quality Control DCP Section N7. It requires developments involving an area greater than 2500 m² must provide treatment measures to address key pollutants in accordance with the following table for all stormwater flows up to 25% of the 1 year ARI peak flow as outlined in **Table 5.3**.

Byron Shire Council Stormwater Treatment Objectives

Pollutant / Issue	Retention Criteria
Litter	70% of average annual load greater than 5 mm
Coarse Sediment	80% of average annual load for particles ≤ 0.5 mm
Fine Particles	50% of average annual load for particles ≤ 0.5 mm
Total Phosphorus	45% of average annual load
Total Nitrogen	45% of average annual load
Hydrocarbons, fuels, oils & grease	90% of average annual load

Table 5.3: – Byron Shire Council Stormwater Treatment Objectives

Predicted water quality and comparison with treatment targets:

Pollutant	Developed Site without treatment (kg/yr)	Developed Site with treatment (kg/yr)	Development Load Reduction (%)	Reduction % Target
Total Suspended Solids	15300	2360	84.6%	80%
Total Phosphorus	37.7	10.4	72.4%	45%
Total Nitrogen	230	105	54.2%	45%
Gross Pollutants	3180	34.0	91% #	70%

Table 5.4: Water Quality Target Comparison

 # Gross pollutant reduction is based on independent testing of Ecosols Net Tech for pollutants greater than 19mm.

As demonstrated in Table 5.4, the proposed development with installed treatment devices will have reductions of TSS, TP, TN and gross pollutants substantially greater that the quality targets for outlined in BSC's Stormwater Quality Control DCP Section N7.

Hydrocarbon reduction is not modelled by MUSIC V3.0. However bioretention basins are considered one of the best methods for removal of hydrocarbons, metals and pathogens.

There is concern about the stormwater quality on the east side of the development (Park 1) and also about general disturbance during construction in this sensitive habitat area. To minimize any impact the proposed earthworks will be limited. Batters along the park frontage will be kept low and made steeper than the usual slopes (up to 1:3) which will extend less than 3m outside the boundary. Bio-filtration beds at pipe outlets and at the back of the lots will ensure the quality of runoff into the park will be within or in excess of the standard requirements. Planting and landscaping will discourage pedestrian access into Park 1; if deemed necessary a perimeter fence could be considered for the habitat area.

6. Erosion and Sediment Control Plan

The purpose of the Erosion and Sediment Control Plan is to protect the development area and the surrounding area from soil erosion and subsequent pollution and sedimentation of waterways.

The principal strategy is to provide "silt" fences, straw bale fences or soil berms downslope of all unprotected disturbed areas to capture any sediment passing from the site. Land disturbance will be limited to that necessary for implementation of the plans of works. Temporary sediment basins shall be sized and constructed for each stage of the proposed development. They will be monitored and maintained on a regular basis.

Works on the site will be carried out in the following sequence:
- installation of barrier and silt fences
- stripping and stockpile of topsoil
- construction of proposed development and site works
- rehabilitation of site with cleanup & removal of rubbish debris
- removal of temporary erosion control works once approved to do so by council.

All works will be implemented and installed in accordance with Landcom & Housing NSW "blue book", *Managing Urban Stormwater, Soils and Construction* and any specific directions of Council.

Temporary rehabilitation shall be undertaken on disturbed areas where works have ceased and soils are expected to remain exposed for more than one month. The contractor will be expected to maintain all water and soil management devices on a daily basis and ensure all vegetation shall be retained beyond limit of works.

Spoil from trenches is to be placed on the uphill side of the trench. The contractor must ensure unfinished pipework is capped with a diaphragm of geotextile filter fabric at the end of each day or at the likely threat of rain. Vehicular access points onto construction site will consist of a gravel pad/stabilised access. Silt traps will be installed at entry to kerb and gutter inlet pits to capture sediment in surface runoff before it enters the pipe network.

A conceptual erosion and sediment control plan is shown in Figure 6. More detail will be provided as part of the construction certificate. Erosion and sediment control will ultimately be fine-tuned by the contractor to suit his construction methods and progress and will be monitored during the construction phase.

Figure 6.Erosion & Sediment Control Concept

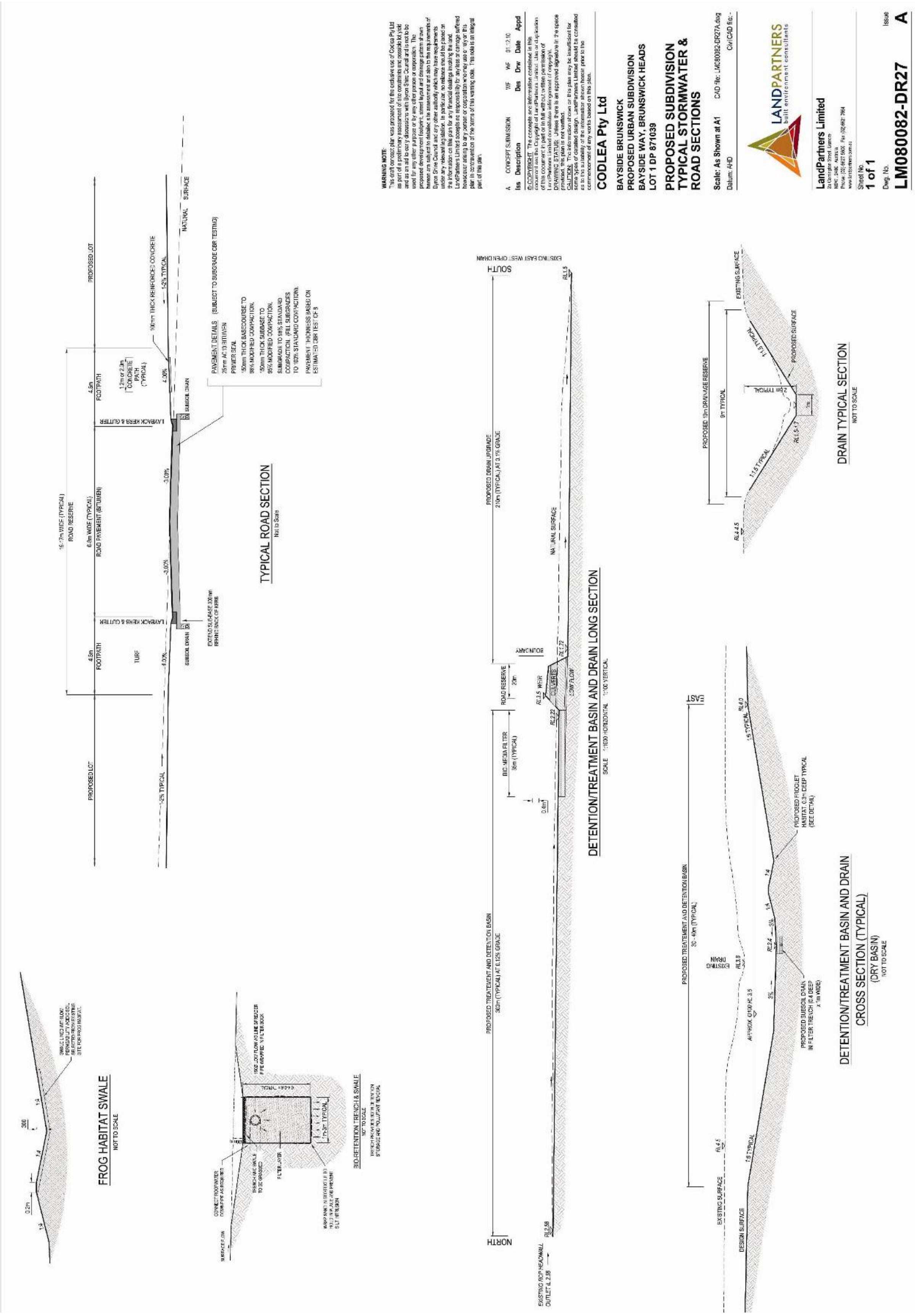


Figure 7. Typical Stormwater and Road Sections

7. Stormwater Detention

Stormwater detention is the creation of stormwater storage devices to attenuate the peak discharge flow rates. Reduction of peak discharge flow rates can be achieved with a combination of infiltration, retention and detention devices. Detention devices are designed to store runoff for longer storm events and gradually release water between storm peaks thus reducing the peak discharge rates.

7.1 Stormwater Detention Requirements

The Northern Rivers Local Government Development and Design Manual V2 outlines the requirements for the peak flows from the post development site in section 12.2.5. The detention shall be designed so that *"the peak flow from the proposed development for the 5, 10, 20, 50 and 100 ARI events, for durations from 5 minutes to 3 hours, does not exceed the existing peak from the site"*.

7.2 Stormwater Detention

The increase in peak discharge flow rates was modelled using DRAINS software. The results of the model are tabulated below which demonstrate that the required targets will be achieved. The bio-retention basin is shown to be adequate to meet the design standards. Additional detention provided by stormwater tanks on each lot and smaller bio-filtration swales was not modelled in detail but will further improve the stormwater detention capacities and runoff control.

8. DRAINS Model

8.1 Drains Model Setup

The DRAINS software used in the stormwater detention modelling is version 2010.03. The model used for the design and analysis of stormwater flows is the Extended Rational Method, which allows for peak intensities within design storms as opposed to the Rational Method which takes an average intensity for the design storm. This model generates higher flows which are more representative of a real storm. This model is only for sizing of detention structures and the generation of hydrographs. Stormwater pipe networks will be sized with CivilCAD 6.9 as per AR&R Guidelines and the Rational Method when a more detailed design is required.

Rainfall hyetographs that have been generated in DRAINS are based on IFD Data for Mullumbimby Zone 3 N.E. Coast. The hyetographs are for each storm 1 year to 100 years, 5 minute up to 72 hours. The model has been run using design storms as specified in the NRLG design manual, Section D5 Clause 12.2.5.

8.2 DRAINS Model Catchments

The total catchment area of the developed footprint plus the small catchment above the proposed detention basin is 19.99ha.

The development primarily discharges south along the existing open drain. Smaller discharges occur to the north, east and west. This discharge layout is retained with 14.41ha passing through the main central basin, 1.04ha to the north, 2.8ha to the east, 1.74ha to the west and south west.

Pre Development Catchment Nodes

Total Area	19.9 ha
Impervious Area	0%
Impervious Tc	0 min
Pervious Area	100%
Pervious Tc	18 min

Post Development Ultimate Catchment Nodes

Central Area	14.16ha
North Area	1.04ha
South Area	0.6ha
East Area	2.8ha
West Area	1.14ha

External Catchment	0.25ha
Typical Impervious Area	35-40% (typical)
Typical Impervious Tc	10 min
Typical Pervious Area	60-65% (typical)
Typical Pervious Tc	18 min

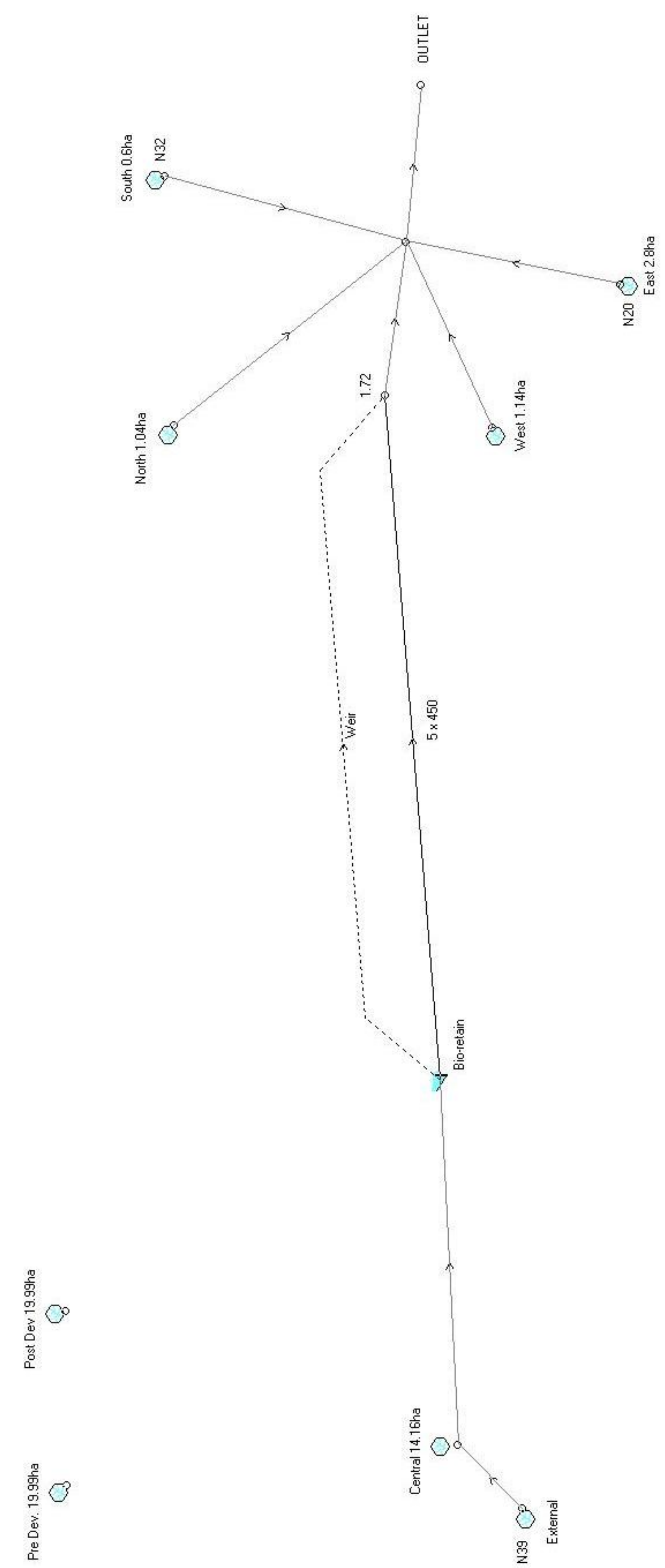


Figure 8: DRAINS Model Schematic

8.3 DRAINS Model Parameters

Stormwater Drainage Networks
The proposed stormwater pits, pipes and overflow routes have not been included in this model. A full in-depth pipe network model will be completed as part of the construction certificate application.

Roof water Detention / Storage Tanks
Installation of rainwater tanks with any new dwelling is encouraged by BASIX. Any installation of tanks would have a dual function, of permanent storage to satisfy the requirements of BASIX and temporary storage to receive and detain the first bursts of rainfall, particularly from storms of high intensity and short duration. Due to the vast amount of stormwater detention available in the bio-retention basin the rainwater tanks have not been included in the DRAINS model. Their inclusion would further improve the detention volume available.

Bio-retention Basins
It is intended to construct a main bio-retention basin in the centre of the development to function as a stormwater quality and stormwater detention device. The location of this basin suits the existing surface levels and thus minimises the amount of cut and fill required. Due to the flat batters and grassed surface of the basin, maintenance will be relatively simple and no public safety fences will be required. The purpose of the basin is to detain the increased stormwater flow from development catchment and slowly release that stormwater after the peak flow from upstream runoff has passed.

Main Bio-retention Basin

Low flow pipe size	2 x 225 dia UNPC (filtration)
Mid flow pipe size	5 x 450 dia RCP (or RCBC equivalent)
Total Volume	3500 m³ at weir crest level
Weir Level	3.5
Weir Length	20m (size to be confirmed with detailed design)

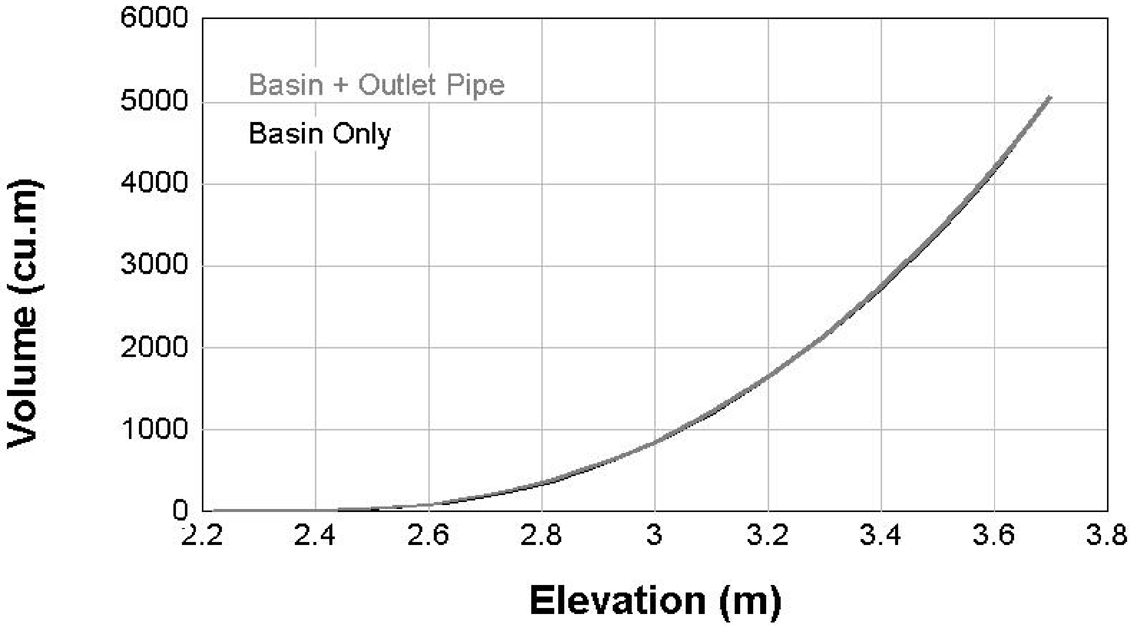


Figure 9: Bio-retention basin staged volume graph

Grassed Overflow Channels

Overflow channels between catchments are based on a typical cross section, longitudinal grade and time of concentration based on the length and iterated velocity.

9. DRAINS Results

9.1 Catchment Peak Flows

The model peak flows from the existing site appear in *Table 9.1* below. The maximum pre-development flows are generated by the 25 minute duration events (critical storms).

Pre Development Peak Flows m³/s							
	1 : 1 ARI	1 : 2 ARI	1 : 5 ARI	1 : 10 ARI	1 : 20 ARI	1 : 50 ARI	1 : 100 ARI
5 min	1.10	1.48	2.03	2.36	2.81	3.53	4.04
10 min	1.69	2.28	3.16	3.69	4.40	5.56	6.37
15 min	2.12	2.86	4.00	4.70	5.61	7.08	8.16
20 min	2.37	3.23	4.53	5.31	6.37	8.01	9.20
25 min	**2.47**	**3.32**	**4.72**	**5.55**	**6.64**	**8.08**	**9.32**
30 min	2.39	3.24	4.59	5.40	6.48	7.87	9.10
45 min	2.28	3.12	4.41	5.20	6.29	7.74	9.00
1 hour	2.38	3.26	4.65	5.49	6.63	8.09	9.39
2 hour	1.94	2.65	3.80	4.52	5.41	6.30	7.37
3 hour	1.69	2.31	3.32	3.96	4.79	5.49	6.39

Table 9.1 – Pre development flows from existing site

Post Development Peak Flows m³/s							
	1 : 1 ARI	1 : 2 ARI	1 : 5 ARI	1 : 10 ARI	1 : 20 ARI	1 : 50 ARI	1 : 100 ARI
5 min	1.60	2.16	2.97	3.45	4.10	5.05	5.66
10 min	2.47	3.32	4.61	5.39	6.42	7.97	8.92
15 min	2.55	3.44	4.80	5.64	6.74	8.31	9.41
20 min	2.92	3.97	5.56	6.52	7.82	9.45	**10.60**
25 min	**3.01**	**4.05**	**5.75**	**6.76**	**8.08**	**9.35**	**10.60**
30 min	2.86	3.87	5.50	6.47	7.76	9.09	10.30
45 min	2.68	3.66	5.18	6.10	7.39	8.90	10.10
1 hour	2.68	3.67	5.23	6.18	7.47	8.95	10.20
2 hour	2.26	3.10	4.45	5.28	6.33	7.24	8.31
3 hour	1.93	2.64	3.80	4.53	5.48	6.16	7.05

Table 9.2 – Post development flows before detention

Post Development Peak Flows m^3/s after detention							
	1 : 1 ARI	1 : 2 ARI	1 : 5 ARI	1 : 10 ARI	1 : 20 ARI	1 : 50 ARI	1 : 100 ARI
5 min	0.78	1.08	1.46	1.69	2.11	2.42	2.59
10 min	1.17	1.54	2.20	2.38	2.65	3.07	3.30
15 min	1.42	2.03	2.46	2.72	3.05	3.52	4.06
20 min	1.56	2.20	2.61	2.88	3.24	4.17	5.23
25 min	1.64	2.24	2.70	2.98	3.36	4.62	5.73
30 min	1.60	2.21	2.64	2.92	3.30	4.72	5.80
45 min	1.59	2.18	2.60	2.87	3.52	5.07	6.24
1 hour	1.85	2.23	2.75	3.05	4.13	5.73	6.95
2 hour	1.52	2.08	2.55	2.83	3.66	4.95	6.11
3 hour	1.38	1.97	2.39	2.67	3.12	4.30	5.38

Table 9.3 – Post development peak flows after detention

Post Development Peak Flows m^3/s change before detention							
	1 : 1 ARI	1 : 2 ARI	1 : 5 ARI	1 : 10 ARI	1 : 20 ARI	1 : 50 ARI	1 : 100 ARI
5 min	45.5%	45.9%	46.3%	46.2%	45.9%	43.1%	40.1%
10 min	46.2%	45.6%	45.9%	46.1%	45.9%	43.3%	40.0%
15 min	20.3%	20.3%	20.0%	20.0%	20.1%	17.4%	15.3%
20 min	23.2%	22.9%	22.7%	22.8%	22.8%	18.0%	15.2%
25 min	21.9%	22.0%	21.8%	21.8%	21.7%	15.7%	13.7%
30 min	19.7%	19.4%	19.8%	19.8%	19.8%	15.5%	13.2%
45 min	17.5%	17.3%	17.5%	17.3%	17.5%	15.0%	12.2%
1 hour	12.6%	12.6%	12.5%	12.6%	12.7%	10.6%	8.6%
2 hour	16.5%	17.0%	17.1%	16.8%	17.0%	14.9%	12.8%
3 hour	14.2%	14.3%	14.5%	14.4%	14.4%	12.2%	10.3%

Table 9.4 – Post development change in peak flows without detention

The change in peak flows shown in *Table 9.4* compare the post developed undetained flows with the pre development flows. Typical increases due to the increase in impervious area range from 10% to 45%.

Post Development Peak Flows m³/s change after detention							
	1 : 1 ARI	1 : 2 ARI	1 : 5 ARI	1 : 10 ARI	1 : 20 ARI	1 : 50 ARI	1 : 100 ARI
5 min	-29.1%	-27.0%	-28.1%	-28.4%	-24.9%	-31.4%	-35.9%
10 min	-30.8%	-32.5%	-30.4%	-35.5%	-39.8%	-44.8%	-48.2%
15 min	-33.0%	-29.0%	-38.5%	-42.1%	-45.6%	-50.3%	-50.2%
20 min	-34.2%	-31.9%	-42.4%	-45.8%	-49.1%	-47.9%	-43.2%
25 min	-33.6%	-32.5%	-42.8%	-46.3%	-49.4%	-42.8%	-38.5%
30 min	-33.1%	-31.8%	-42.5%	-45.9%	-49.1%	-40.0%	-36.3%
45 min	-30.3%	-30.1%	-41.0%	-44.8%	-44.0%	-34.5%	-30.7%
1 hour	-22.3%	-31.6%	-40.9%	-44.4%	-37.7%	-29.2%	-26.0%
2 hour	-21.6%	-21.5%	-32.9%	-37.4%	-32.3%	-21.4%	-17.1%
3 hour	-18.3%	-14.7%	-28.0%	-32.6%	-34.9%	-21.7%	-15.8%

Table 9.5 – Post development change in peak flows with detention

The change in peak flows shown *Table 9.5* compare the post developed detained flows with the pre development flows and demonstrate the overall reduction in peak flow rates at the outlet.

9.2 Bio-filtration Basin Inflow / Outflow Hydrographs

To assess the detention effect of the main bio-filtration basin on the peak site discharge Inflow / outflow hydrographs were generated for all ARI events. A spike in the outflow the basin is full and there is weir overflow which happens on events 20 years and greater. All hydrographs are for the critical 25 minute storm.

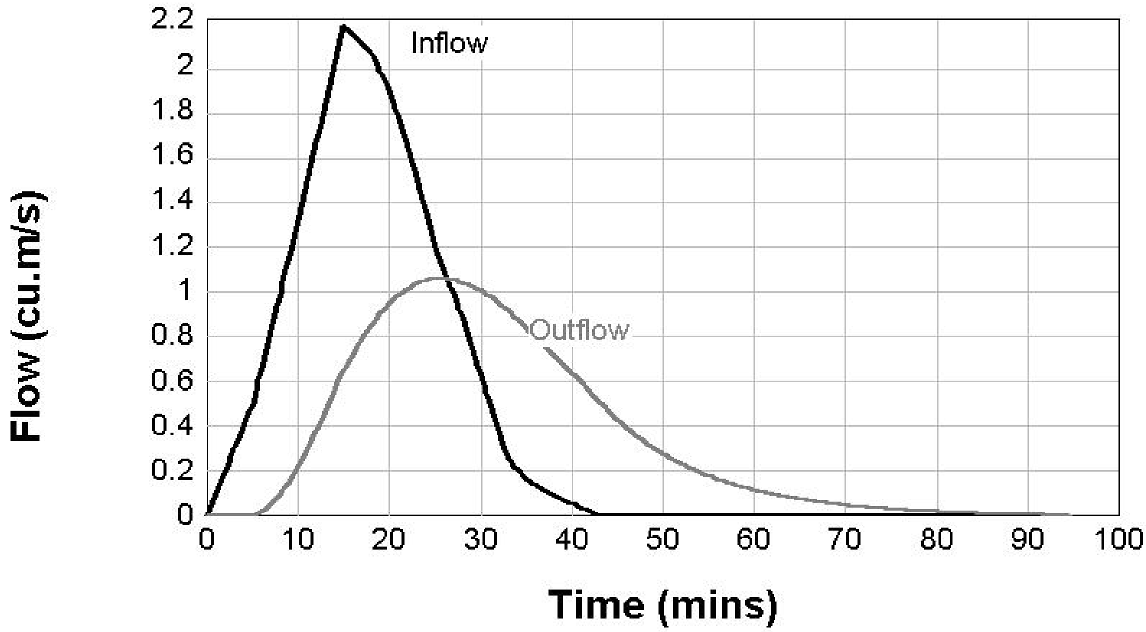


Figure 10 –1 year 25 min Hydrograph

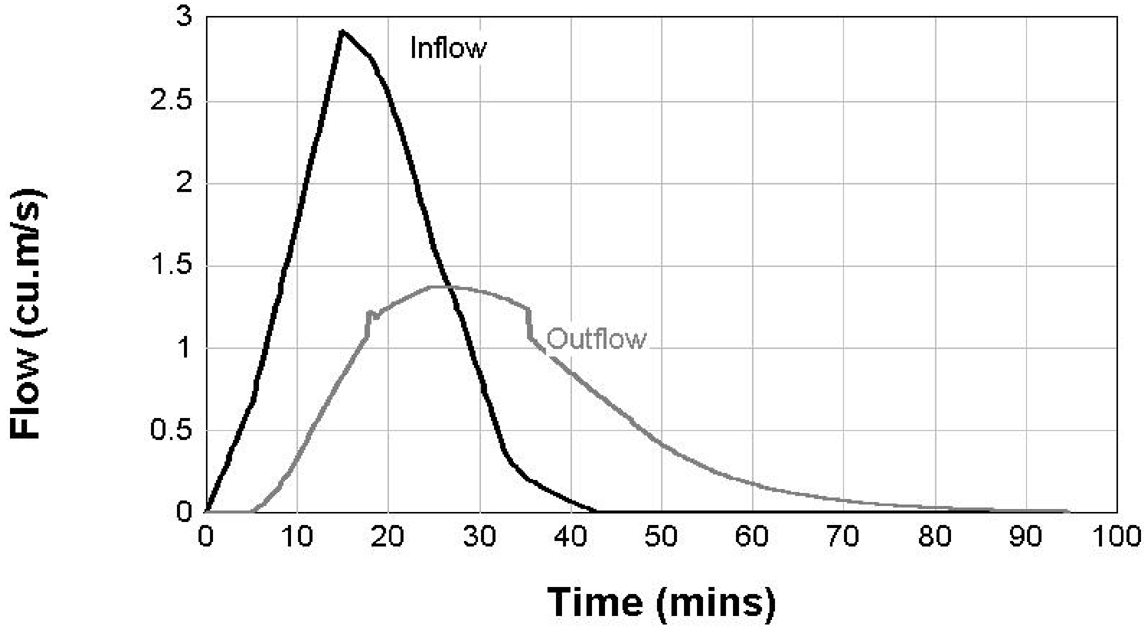


Figure 11 – 2 year 25 min Hydrograph

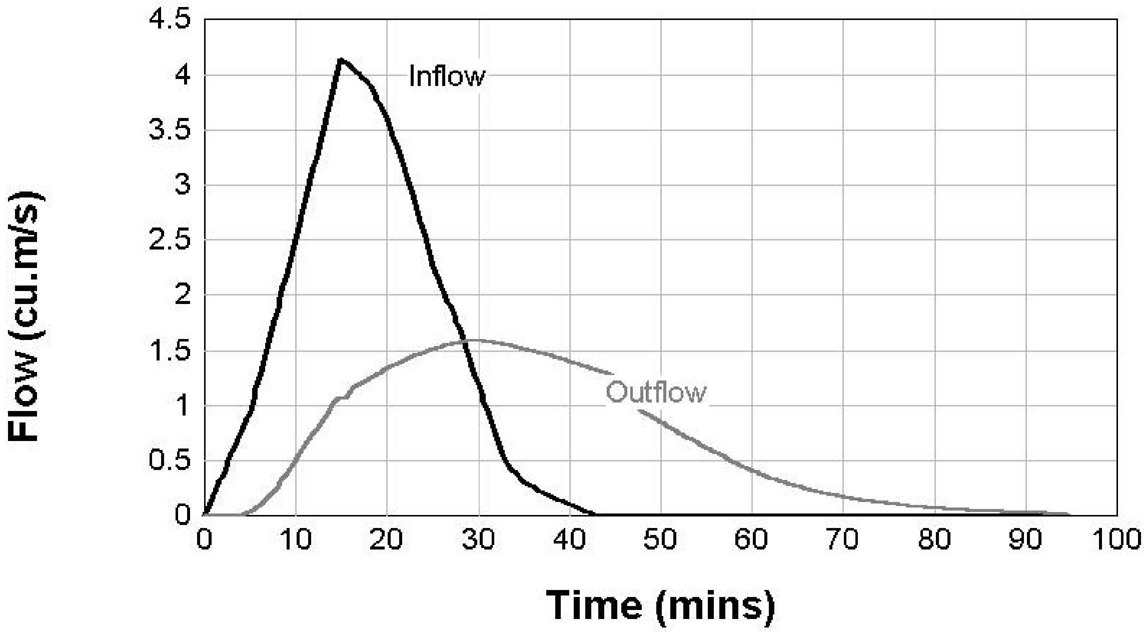


Figure 12 – 5 year 25 min Hydrograph

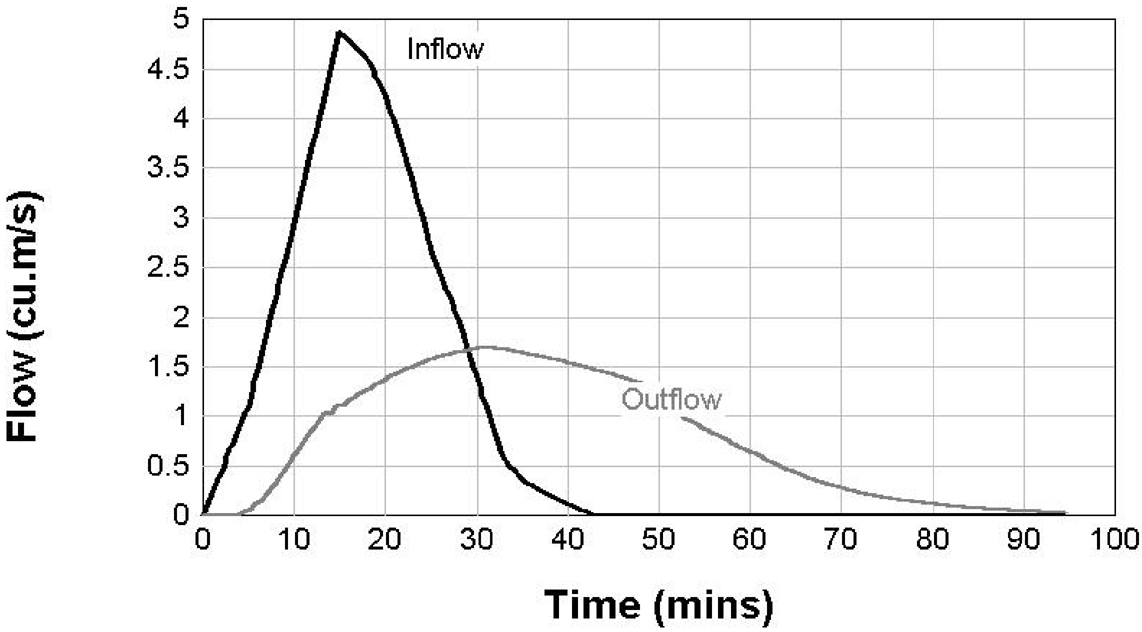


Figure 13 – 10 year 25 min Hydrograph

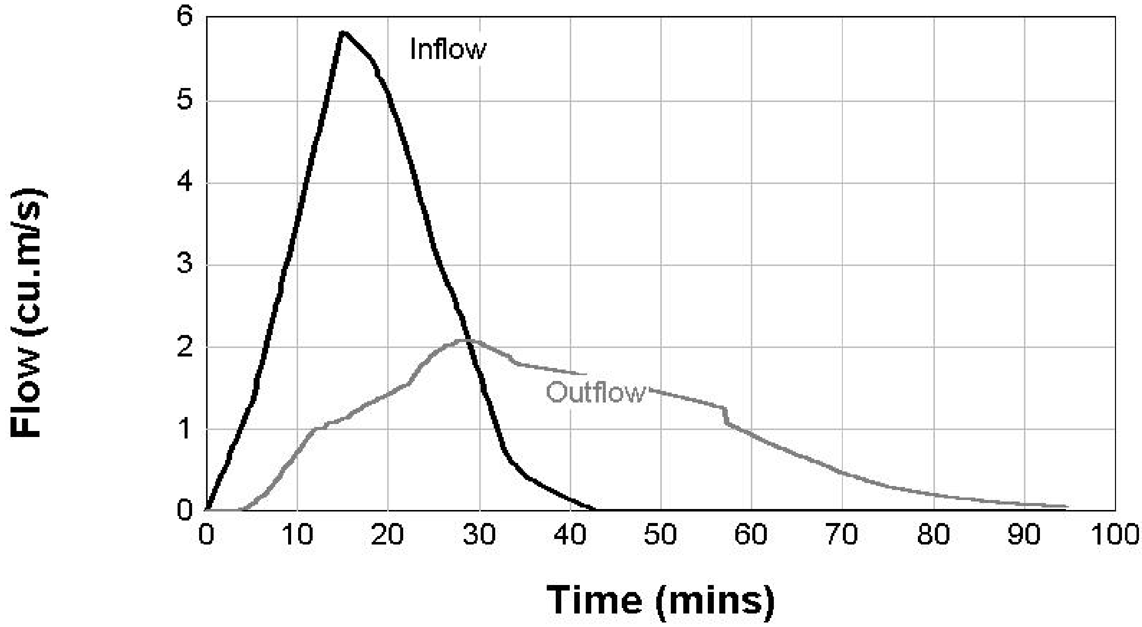


Figure 14 – 20 year 25 min Hydrograph

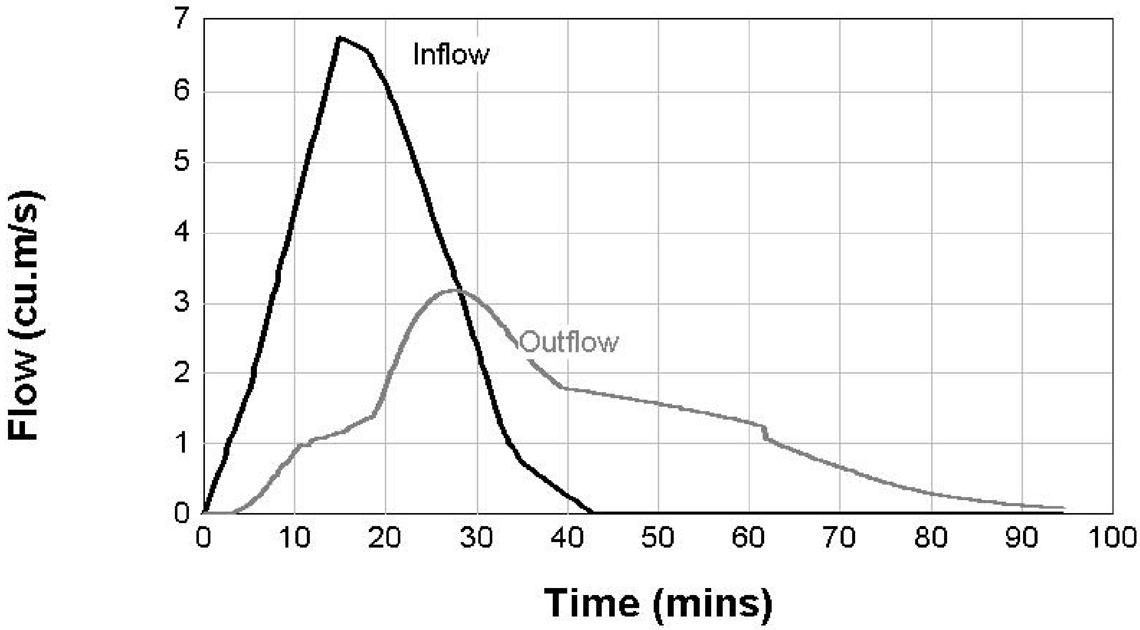


Figure 15 – 50 year 25 min Hydrograph

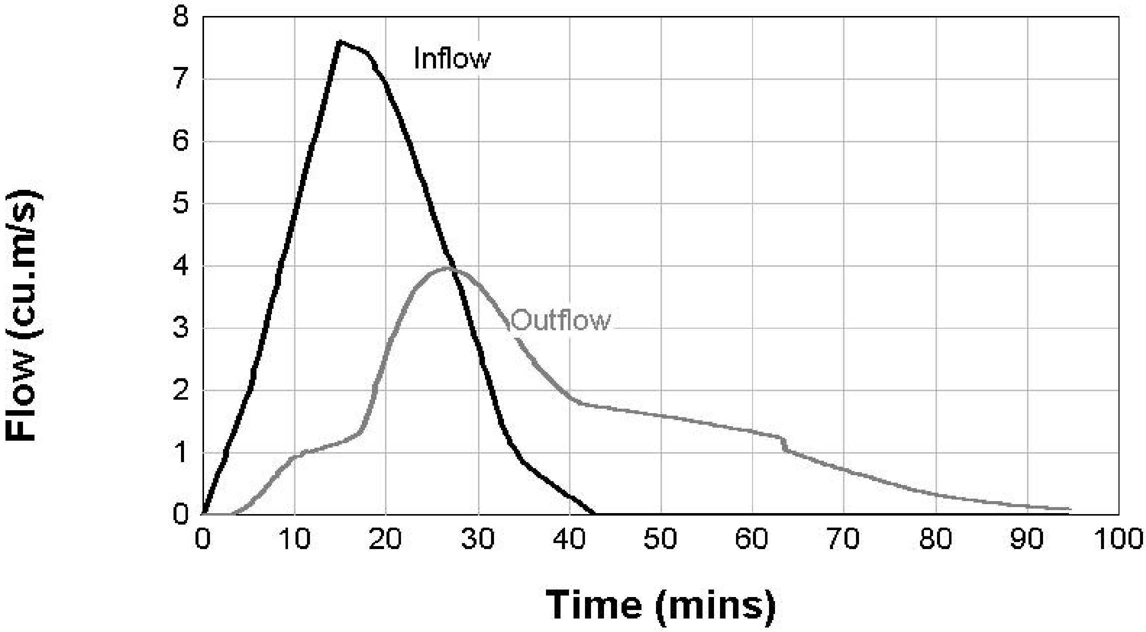


Figure 16 – 100 year 25 min Hydrograph

9.3 Discussion of Results

In order to achieve a combined flow for the whole catchment for easy comparison the model was run with a virtual outlet in which the flows from the separate catchments outlets were added together into one hydrograph as indicated in Figure 8.

Using this device is was possible to confirm by running the model for the pre and post development case that peak flows for the whole catchment will be reduced if a detention basin as proposed is provided. It should be noted that this is a conceptual model only and refinements such as rainwater tanks and infiltration trenches on individual lots have not been included. In essence this means that only the main basin in Park 2 is reflected in the model. The results show that even with this coarse analysis the flow reduction targets will be achieved. All the detention features not modelled yet will provide further reductions in peak flows.

At this stage it was determined that more detailed analysis would not add to the substance of the model outcome and was omitted. A model with more comprehensive detail and all minor features included will be set up for the site at the time of construction certificate submission.

Table 9.5 shows details of the reduction ratios as compared with the pre development flows. Tables 9.1 and 9.2 compare the pre and post development flows for the range of design events. The main effect of detention, namely the reduction of peak flows and the lengthening of the durations for the critical events is reflected consistently in the tables and the outflow hydrographs. The duration of the critical events changes from 25 min (pre development) to 1 hour (post development).

10. Stormwater Device Maintenance

A satisfactory stormwater management solution must result in acceptable pollutant levels and peak flow discharges but must also be safe to the public and easy for Council to maintain.

There are several advantages from the implementation of a bio-retention basin as compared to permanent wetlands:

- Public safety is greatly increased. With flatter batters in the order of 1:6 (Refer Figure 7) and a basin that is typically dry, no safety fence is required.
- Environmental and health concerns are reduced - no habitat for mosquito or cane toad breeding and public safety is improved with less shelter for snakes.
- Maintenance by Council is greatly reduced. Typical maintenance would involve:
    - the mowing of the open space/filtration grassed area on a fortnightly or monthly basis, depending on the season;
    - emptying of the Net-tech nets at the GPTs at typical 6 month periods.

11. Conclusion & Recommendations

The purpose of this assessment is to identify the effects of the proposed development upon the existing stormwater conditions on site, and to provide recommendations for stormwater detention and treatment measures in accordance with Byron Shire Councils Stormwater Quality Control DCP Section N7.

MUSIC modelling of the existing site and against the proposed development demonstrates that with the use of gross pollutant traps and bio-retention basin achieved excellent output concentrations of all stormwater pollutants as specified by the Byron Shire Councils Stormwater Quality Control DCP Section N7

Figures in Table 5.4 show that all pollutant targets will be achieved with the proposed stormwater quality devices. Overall there is a 84.6% reduction in Total Suspended Solids, a 72.4% reduction in Total Phosphorus, a 54.2% reduction in Total Nitrogen levels and a 91% reduction in Gross Pollutants.

The stormwater pollutant levels were calculated from theoretical modelling parameters provided by Tweed Shire Council. It is possible that the model input parameters prescribed by the Council guidelines are conservative and may exaggerate the effects of the development.

To accurately determine the stormwater pollutant levels, water testing should be carried out on site. Monitoring of the water quality at the outlets and further downstream in the receiving waters for representative runoff events may be required to assess the accuracy of the modelling.

The implementation and maintenance of an Erosion and Sediment Control plan as outlined in Section 6 during construction is crucial. By following the prescribed ESCP both the level of erosion will be minimised and sediment discharge from site will be greatly reduced. As discussed it is important that the erosion and sediment control measures are regularly checked, maintained and upgraded to suit the current construction phase.

DRAINS modelling of the existing site and against the proposed development demonstrate that the use of the bio-retention basin will provide sufficient detention storage for the development.

The requirement of the NRLG Development and Design Manual is that *"the peak flow from the proposed development for the 5, 10, 20, 50 and 100 ARI events, for durations from 5 minutes to 3 hours, does not exceed the existing peak from the site"*. As is demonstrated in Table 9.5 the post development combined flows are reduced for all events.

Our recommendation for managing the stormwater runoff quality is the installation of Ecosol Net Tech gross pollutant traps at all headwall outlets and a bio retention basin located in the centre of the development. This system would not only provide a solution which achieves high water quality targets but is also easy to maintain.

Our recommendation for the detention of peak stormwater flows is the construction of a bio retention basin located centre of the development. This will significantly reduce all peak storm events and most importantly reduce the critical events to below pre-developed flow rates. This not only reduces the flooding impact on site and downstream but will also aid the treatment of stormwater quality.

By implementing these measures the development will comply with the stormwater management requirements of the Byron Shires DCP 2002 Stormwater Management Part N and the Northern Rivers Local Government – Handbook of Stormwater Drainage Design.

The final stormwater management plan and design details for stormwater detention and quality devices will be submitted as part of a construction certificate application.

12. References

Byron Shire Council: *Development Control Plan 2002, Part N – Stormwater Management.*

Byron Shire Council: *Development control Plan No 6- Bayside Brunswick*

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Border Tech Geotechnical Engineering Services: *Report BT 19034-1 / May 2009*

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NSW Environmental Protection Authority, 1997: *Managing Urban Stormwater: Treatment Techniques (DRAFT)*

Wong. T, 2000, Australian Runoff Quality Design Guidelines.